Remarks

By way of the foregoing amendments, each of the independent claims has been amended to stipulate the provision of a pair of opposite *permanent* magnet poles (taken from claim 4) defining an axis that is aligned tangentially to a circumferential surface of the shaft, with corresponding changes in the dependent claims where appropriate. Claims 12 and 15 have been amended to avoid any issue as to lack of antecedent basis, and claims 4 and 5 have been canceled.

The various parts of the Office Action (and other matters, if any) are discussed below under appropriate headings.

Claim Rejections - 35 USC § 112

Claim 2 was rejected under 35 USC § 112, ¶ 2 as indefinite. The Examiner's objection to claim 2 is not understood since there appears to be no ambiguity present. Claim 1 recites "at least one flux detector," while claim 2 specifies that the "at least one flux detector comprises a pair of torque-sensing flux detectors." This is a long accepted claiming practice and does not render claim 2 indefinite.

Claim Rejections - 35 USC § 103

The claims were rejected under 35 USC § 103(a) as being unpatentable over U.S. Patent No. 5,351,555 to Garshelis ("Garshelis") in view of U.S. Patent No. 4,364,278 to Horter et al. ("Horter") and/or U.S. Patent No. 4,803,885 to Nonomura et al. ("Nonomura"). Withdrawal of the rejections is respectfully requested for at least the following reasons.

Amended claim 1 recites a torque sensor which includes a shaft comprising magnetostrictive material and a pair of opposite permanent magnet poles which define an axis which is aligned tangentially to a circumferential surface of the shaft. The opposite permanent magnet poles induce a localized magnetic field in the magnetostrictive material. At least one torque-sensing flux detector is provided for detecting a component of the localized magnetic field which escapes from the magnetostrictive material in the shaft when the shaft is torqued. Similarly, independent claims 11, 13, 14, and 17 each set forth a torque sensor comprising a shaft comprising magnetostrictive material and a pair of opposite permanent magnet poles which define an axis which is aligned tangentially to a circumferential surface of the shaft, whereas method claim 18 recites, *inter alia,* using a pair of torque-sensing flux detectors

positioned on opposite sides of the shaft circumferentially displaced from the pair of opposite permanent magnet poles.

Garshelis describes a torque sensor 2 which is mounted on shaft 8. The torque sensor 2 comprises a transducer 4 which takes the form of a ring of material endowed with an effective uniaxial magnetic anisotropy such that the circumferential direction is the easy axis, and magnetically polarized in a substantially circumferential direction. A magnetic field vector sensor 6 is also provided. Thus, the torque sensor 2 comprises neither a shaft comprising magnetostrictive material, nor a pair of opposite permanent magnetic poles defining an axis that is aligned tangentially to a circumferential surface of the shaft as set forth in each independent claim.

Furthermore, Garshelis appears to teach away from the arrangement set forth in the claims. Instead of providing a separate magnet for inducing a localized magnetic field in a magnetostrictive material, a *premagnetized* magnetoelastically active portion (the transducer 4) is provided. In column 8 of this document from lines 24 to 39, it is described that a fixed refresh magnet 47 can be provided proximate to the transducer 4 (see also Figure 4). Instead of inducing a localized magnetic field in a transducer 4 , the refresh magnet 47 provides a continual *low level* magnetic force on a transducer which tends to maintain the desired polarization thereof. Indeed, it is explicitly stated in column 8 at line 30 that the magnet 47 can be relatively weak since *it need not be strong enough to actually polarize the entire transducer*, but must only be able to correct any wayward domains which develop during extended operation of the device in the field. Therefore, Garshelis teaches away from providing a separate magnet for inducing a localized magnetic field in a magnetostrictive material.

Horter describes an assembly for monitoring torsional loading of a drive shaft. This document is silent with regard to the use of opposite *permanent magnetic poles*. Indeed, this document teaches away from the use of permanent magnets altogether since the field applied by the electromagnetic energization coils 81-84 are taught to be "AC" (as opposed to DC, as would be provided by a permanent magnet). Indeed, the approach taken in this document is entirely different in that AC field excitation is used to measure *changes in permeability* of the cylindrical body 11 as opposed to measuring field changes in a magnetostrictive material (this difference is acknowledged in US 5,351,555 in column 2, paragraph 1, which acknowledgment suggests that the skilled person would not consult Horter when considering the former document).

Similarly, Nonomura describes a torque measuring apparatus which employs AC field excitation (see, for example, column 8, lines 14 to 28). Again, this document

describes the measurement of changes in permeability and not the measurement of field changes in a magnetostrictive material. Furthermore, the exciting coil device used in Nonomura magnetizes the shaft in its *axial* direction (see abstract, lines 6 to 9 and also the passage cited above), in stark contrast to a tangential arrangement.

Thus, none of the documents discussed above, alone or in combination, either teach or suggest the combination of features recited in the independent claims. Therefore, claims 1-7 and 10-18 are patentable over Garshelis in view of Horter, and claims 8-9 are patentable over Garshelis and Horter, in further view of Nonomura, for at least the foregoing reasons.

Conclusion

In view of the foregoing, request is made for timely issuance of a notice of allowance.

Respectfully submitted,

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